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# Clinical and imaging findings of walled-off pancreatic necrosis misdiagnosed as an intra-abdominal neoplasia in a Schnauzer dog: A case report

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**Abstract:** A 10-year-old Schnauzer presented with a 1-month history of vomiting, anorexia, and abdominal pain, and a recently detected intra-abdominal mass. The round, soft-tissue opacity masses identified on the radiography in the left mid-abdomen were confirmed as multifocal, cystic masses via ultrasonography. The necrotic masses mimicked an intra-abdominal neoplasia on the initial imaging examinations. The computed tomography (CT) clearly showed encapsulated masses with a necrotic fluid arising from the left limb of the pancreas and extending to the peripancreatic, paracolic, and perigastric regions. Based on the multimodal imaging, surgical exploration, and histopathology, the mass was diagnosed as a walled-off pancreatic necrosis (WOPN). CT is an effective diagnostic modality for diagnosing acute pancreatitis in WOPN.

**Keywords:** acute pancreatitis; computed tomography; necrotic debris; necrotizing pancreatitis; peripancreatic fluid collections

Pancreatitis is a common gastrointestinal disorder in dogs; it is classified into acute and chronic pancreatitis. Although acute pancreatitis is not associated with permanent parenchymal changes, it can induce various local and systemic complications that have a clinical importance in dogs (Mansfield 2012). Acute pancreatitis is subdivided into interstitial oedematous pancreatitis and necrotising pancreatitis (NP); both conditions can lead to various complications in the pancreatic parenchyma and the adjacent organs.

In humans, NP is a severe form of acute pancreatitis and is defined as the necrosis of the pancreatic parenchyma with peripancreatic tissues (Thoeni 2012; Zaheer et al. 2013). Since the disease has high morbidity and mortality associated with systemic inflammatory response syndrome, imaging modalities, primarily computed tomography (CT), play an essential role in the diagnosis and assessment of the peripancreatic fluid collections (Trout et al. 2010; Bharwani et al. 2011; Baudin et al. 2012). Based on the revised Atlanta classification system (Thoeni 2012), peripancreatic fluid collections are classified into four different types: acute peripancreatic fluid collection, pancreatic pseudocyst, acute necrotic collection, and walled-off pancreatic necrosis (WOPN). Among them, pseudocyst and WOPN occur more than

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4 weeks after the onset of pancreatitis and have clinical relevance due to the mass-like lesions that are formed and often misdiagnosed as abdominal masses. There have been several reports on WOPN, which is a known NP complication in humans; however, to our knowledge, there has been only one report on WOPN in veterinary medicine (Hwang et al. 2018). The aim of this case report was to describe the clinical and imaging findings of WOPN as an NP complication in dogs to establish the basis of a diagnosis in the future.

## Case description

A 10-year-old, spayed, female, Schnauzer weighing 7 kg, presented with a 1-month history of vomiting, anorexia, and abdominal pain, and a recently detected intra-abdominal mass on an ultrasonographic examination. The dog was diagnosed with acute pancreatitis and treated at the first visited animal hospital. However, the owner recently recognised an abdominal distension, thus raising a concern.

On the physical examination, only mild hyperthermia (39.0 °C) and an abdominal distension were noted. The complete blood counts and serum biochemistry profile revealed leukocytosis (45; reference range, 6–17 × $10^9$/l) and increased amylase (3 300; reference range, 388–1 007 IU/l), lipase (1 991; reference range, 0–1 800 IU/l), C-reactive protein (CRP) (130; reference range, 0–20 mg/l), and canine pancreatic lipase (cPL) (881; reference range, 0–200 ng/ml) levels.

Routine radiographs were obtained (Figure 1) (Titan 2000M; Comed Medical Systems, Seoul, Republic of Korea). In the lateral radiograph, a decreased serosal detail of the entire abdominal cavity with a moderate mass effect was detected. The hazy, round masses were compressing and dislocating the adjacent small intestines caudoventrally. On the ventrodorsal projection, heterogeneous soft-tissue opacity masses were noted on the left-side of the abdomen, dislocating the small intestines to the contralateral side.

An ultrasonographic examination was performed (Figure 2) (Aplio 500; Toshiba Medical System, Tokyo, Japan). Enlarged, an oedematous hypoechoic pancreatic parenchyma with irregular septations was visible, specifically in the left pancreatic limb. Multifocal, round, hypoechoic cystic masses were noted in the left mid-abdomen, adjacent to the descending colon, greater curvature of the stomach, and spleen. A small amount of peritoneal effusion and increased mesenteric and omental fat echogenicity were noted. There were no remarkable findings in the descending duodenum and biliary tracts.

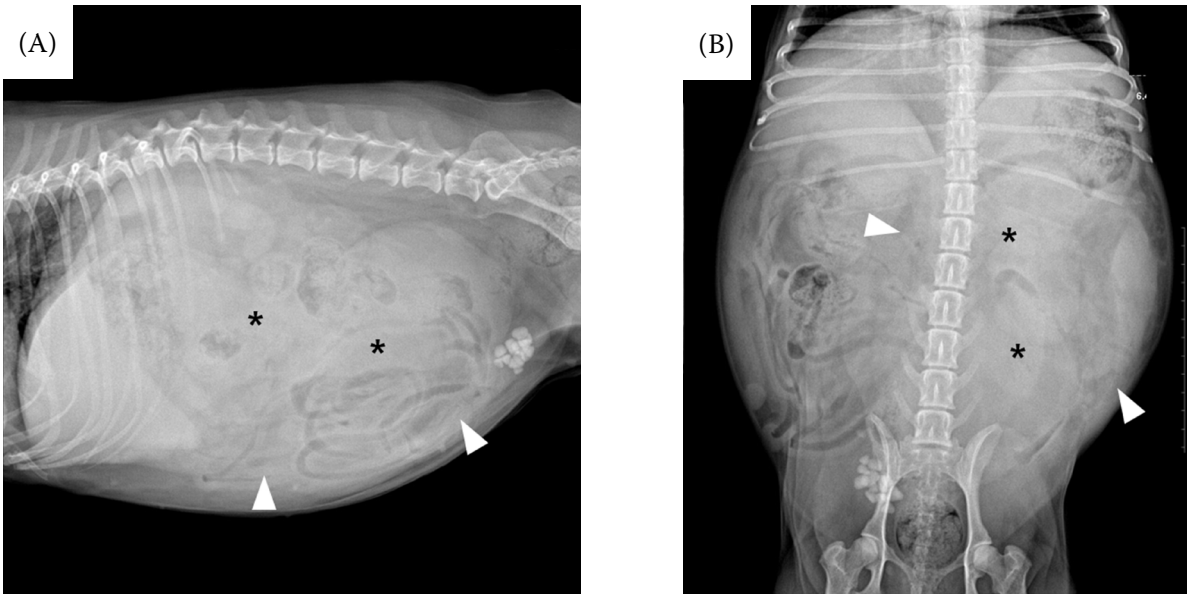


Figure 1. Lateral (A) and ventrodorsal (B) radiographs of the abdominal cavity
At the left-mid abdomen, soft-tissue opacity round intra-abdominal masses are visible (asterisks). The masses deviate the small intestines towards the opposite site. Around the mass, remarkably decreased serosal details are found (arrowheads). Concurrently, round radiopaque materials at the region of the urinary bladder consistent with calculi are visible

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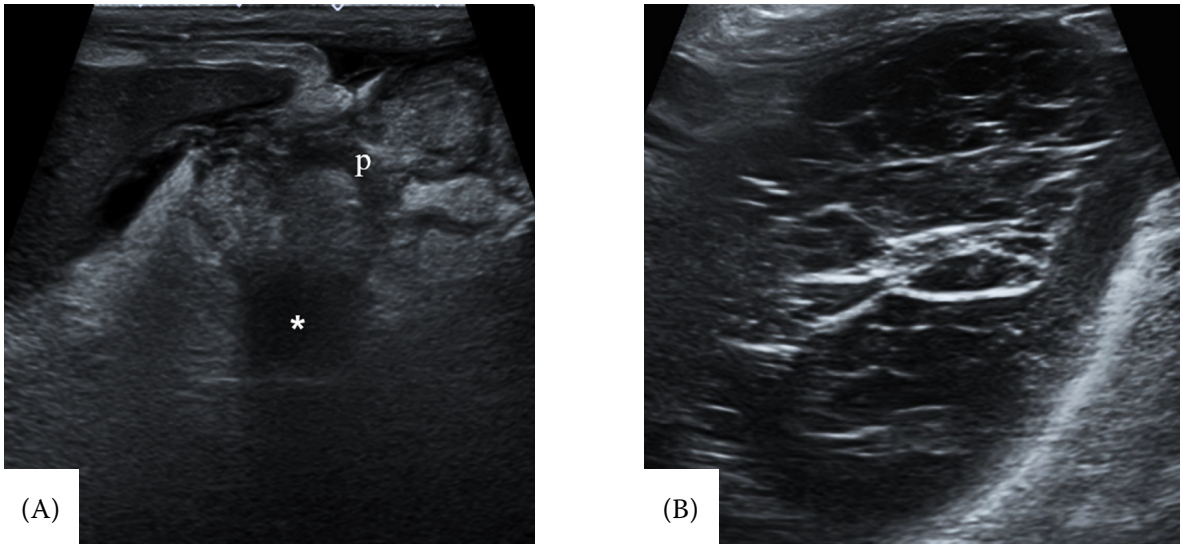


Figure 2. Abdominal ultrasonographic findings at the left limb of the pancreas (A) and the intra-abdominal mass (B)
The left limb of the pancreas (P) shows an irregularly increased echogenicity with a multiple hypoechoic septum. The multifocal, round, hypoechoic masses with multiple cysts are visible. Note that the hypoechoic, round fluid collection is visible at the peripancreatic area (asterisk)

Computed tomography (Brivo CT385; GE Healthcare, Waukesha, WI, USA) was used to evaluate the intra-abdominal mass and pancreas. Anaesthesia was induced with propofol (6 mg/kg, Provive 1%; Myungmoon Pharmaceutical Co., Seoul, Republic of Korea). Following the endotracheal intubation, the anaesthesia was maintained with 2% isoflurane (Forane solution; Choongwae Pharma Corporation, Seoul, Republic of Korea). With the dog in the ventral recumbency position, a CT was performed in the helical mode using soft tissue algorithms with the following scan parameters: 100 kVp; 200 mAs; slice thickness 0.125 mm, without gantry tilting. To obtain post-contrast images, a contrast medium (Omnihexol 300; Korea United Pharmaceutical, Seoul, Republic of Korea) at a dose of 600 mg iodine/kg was rapidly injected by hand into the left cephalic vein, and one post-contrast scan was performed 60 s after the injection.

On the post-contrast transverse plane image (Figure 3), the left limb of the pancreatic parenchyma was mildly enlarged and showed oedematous changes with peripancreatic fat stranding. At the tip of the pancreas, an irregular heterogeneous enhancement of the pancreatic parenchyma, consistent with necrosis, was noted. Encapsulated hypoechoic non-enhancing soft-tissue attenuating masses (15–20 Hounsfield units) were located in the peripancreatic (5.3 × 5.8 × 2.6 cm), paracolic (3.2 × 6.5 × 12.8 cm), and perigastric (5.2 × 3.5 × 4.1 cm) regions with well-defined margins. Around the spleen, extensive fat stranding with loculated fluid collections were noted; this was consistent with acute necrotic fluid collections. The fluid collections compressed the adjacent organs including the left kidney, spleen, and descending colon. A regional lymphadenopathy involving the gastric, hepatic, and pancreaticoduodenal lymph nodes, was noted. The dog was tentatively diagnosed with NP with extensive peripancreatic necrosis and diffuse peritonitis based on the clinical and imaging findings.

A peritoneal lavage and exploratory laparotomy were performed to relieve the abdominal pain and peritonitis (Figure 4A). The surgery was performed in a routine manner with a ventral midline incision. At the level of the left upper abdomen and retroperitoneum, a severe adhesion formation, fat necrosis, and peritonitis were noted. Most of the small intestine was deviated to the right side, and a fat necrosis and a palpable mass surrounded by fat were mainly identified on the left side. The right limb of the pancreas was identified as having a normal appearance, but identification of the left limb was difficult due to the severe adhesion. The mass was excised using a blunt dissection to free it from the adhesion regions. Furthermore, 350 ml of a cloudy and viscous peritoneal effusion was suctioned. After flushing the abdominal cavity several times with warm saline, a closed active

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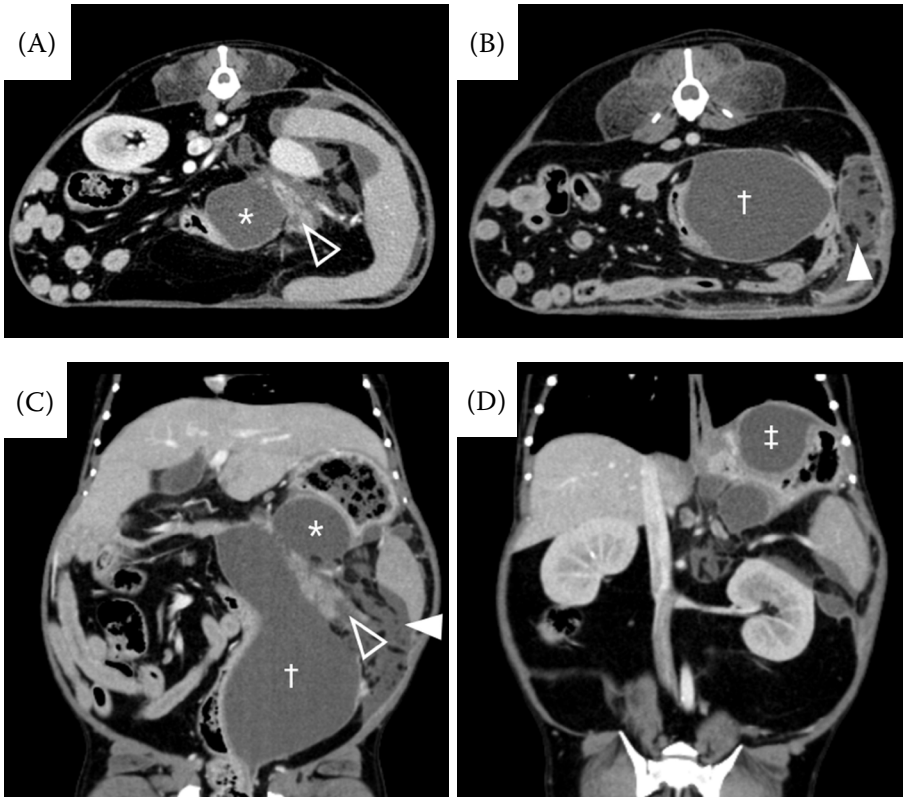


Figure 3. Post-contrast computed tomography findings at the level of the pancreas (A), descending colon (B and C), and kidney (D)
The left limb of the pancreas shows an oedematous, heterogeneously enhanced parenchyma (open arrowheads, 80–100 Hounsfield units). Sharply demarcated, multifocal hypoattenuating masses (15–20 Hounsfield units) are visible at the peripancreatic region (asterisks), paracolic space (daggers), and perigastric area (double dagger). There is also fat stranding and a fluid attenuating lesion in the left-mid abdomen consistent with acute necrotic fluid collections (white arrowheads). A and B, transverse plane; C and D, dorsal plane

Jackson-Pratt drain was installed. The abdominal wall, subcutaneous tissues, and cutaneous tissues were closed in a routine manner.

The cytologic analysis of the peritoneal effusion revealed only a few red blood cells and foamy macrophages without any infectious agents. The aerobic and anaerobic cultures of the peritoneal effusion were negative. The histopathologic results (Figure 4B) revealed that the adipose tissue was multifocal in the coalescing areas of the

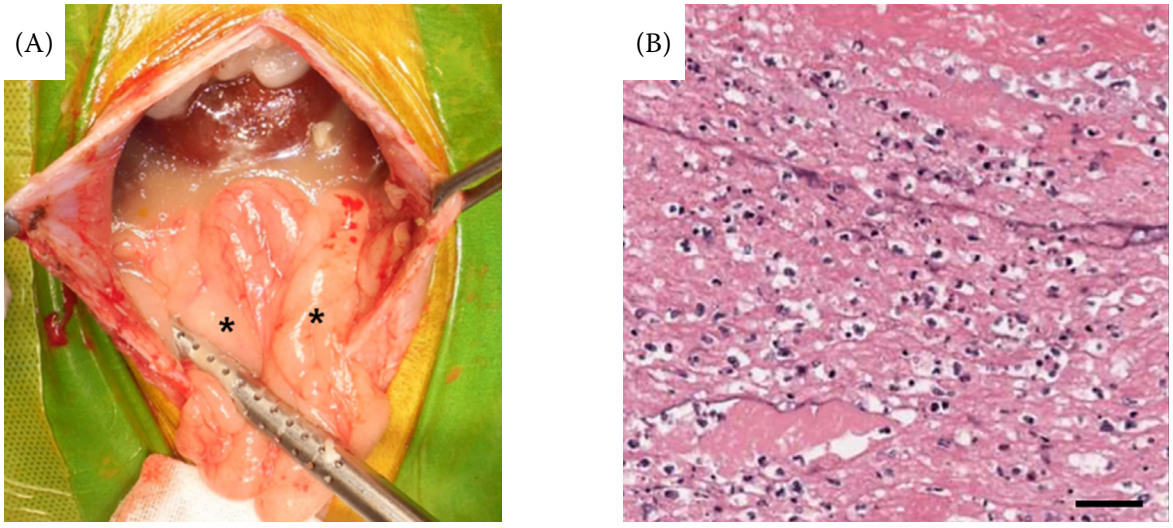


Figure 4. Intraoperative (A) and histopathological (B) findings in the dog
On the exploratory laparotomy, extensive adhesion formation and fat necrosis in the left upper abdomen and retroperitoneal cavity can be observed. The encapsulated masses surrounded by the intra-abdominal fat (asterisks) compress the adjacent small intestines. The histopathologic result shows necrotic adipocytes with saponification, multifocal to the coalescing area of the necrosis with numerous visible degenerate neutrophils, macrophage, fibrin, cell debris, and basophilic granular materials. Bar = 5 μm

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necrosis with numerous degenerative and viable neutrophils, macrophages, fibrin, cell debris, and basophilic granular materials. The mass showed inflammation and necrosis in the fat tissue without evidence of a neoplasm; the affected adipocytes were necrotic with saponification consistent with WOPN.

After surgery, the dog recovered uneventfully with postoperative antibiotics administered for 9 days (cefazolin 22 mg/kg, i.v., every 12 h and metronidazole 10 mg/kg, i.v., every 12 h). At the follow-up visit 5 weeks after the surgery, the haematological profile had returned to its reference ranges. No intra-abdominal mass or a mass effect was visible on the radiographs. Additionally, the hypoechoic masses were distinctly decreased in size and were only identified in the peripancreatic area on the abdominal ultrasonography (Figure 5). Based on the clinical and multimodal imaging findings, the dog was finally diagnosed with NP and WOPN caused by extensive sterile peritonitis.

## DISCUSSION AND CONCLUSION

WOPN is a long-term sequel of acute pancreatitis that occurs at least 4 weeks after the onset of NP (Thoeni 2012). In humans, NP accounts for 20–30% of acute pancreatitis cases (Stamatakos et al. 2010; Hughey et al. 2017) and can develop into a life-threatening disease if adequate treatment is delayed (Mier et al. 1997; Thoeni 2012). Therefore, the clinical and imaging characteristics of WOPN are well-established, and the Atlanta classification has outlined clear criteria for the clinical assessment and management of acute pancreatitis (Thoeni 2012). Acute pancreatitis is also a common disease in veterinary medicine and although the prevalence of acute pancreatitis in the canine population is not well-known, the mortality rate in dogs was reported to be 27–58% in some recent studies (Mansfield 2012; French et al. 2019). There have been several reports of acute pancreatitis and pancreatic abscesses which are known complications of NP; however, WOPN is not well-established

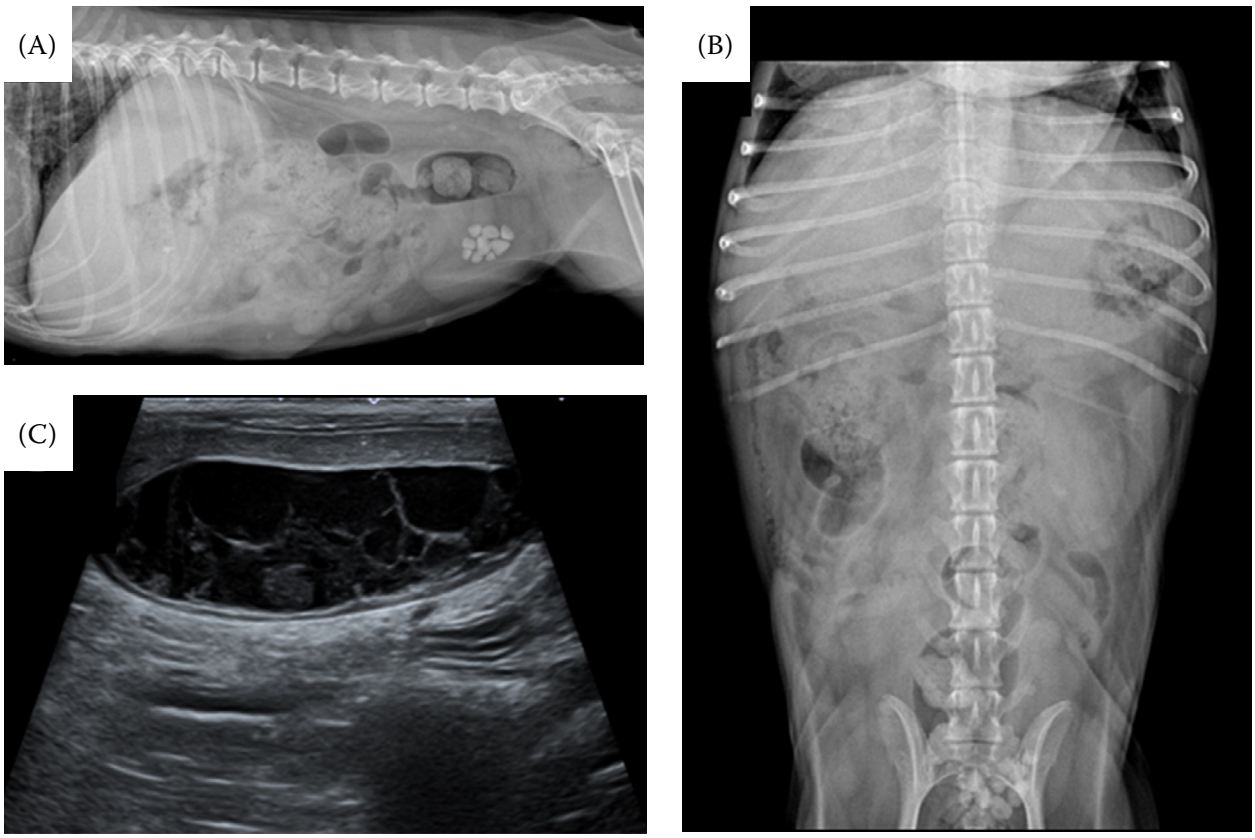


Figure 5. Radiographs (A and B) and abdominal ultrasonographic images (C) for the dog at the 5 week-follow-up after surgery

There are no remarkable masses and normal serosal details can be observed throughout the abdominal cavity. The ultrasonography revealed that the hypoechoic masses distinctly decreased in size showing more cystic characteristics

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in veterinary medicine. This case report is intended to provide a basis for the diagnosis of WOPN, which may be misdiagnosed as an intra-abdominal mass in small animals based on the clinical and imaging findings.

WOPN consists of an encapsulated collection of pancreatic and/or peripancreatic necrosis and a thickened non-epithelised wall between the necrosis and the adjacent tissue (Thoeni 2012). There can be single or multiple necrotic fluid collections (Hughey et al. 2017). Low-attenuated fluid collections replace the pancreatic necrosis area and can be observed to extend into the peripancreatic space with well-defined walls on CT imaging in humans (Takahashi et al. 2008; Thoeni 2012; Zaheer et al. 2013). Similar to previous reports in humans, acute necrotic fluid collections with well-defined walls were identified in the left mid-abdomen, adjacent to the descending colon, greater curvature of the stomach, and spleen in the present case. Pancreatic necrotic debris without any enhancement is another common characterisation of WOPN (Cunha et al. 2014). Necrotic debris is not always identified using CT, but it may be analysed using a narrower window (Morgan et al. 1997). In WOPN, pancreatic necrotic debris is identified because the pancreatic necrosis replaces part of the pancreatic parenchyma (Thoeni 2012; Cunha et al. 2014). However, in the only previously reported case in veterinary medicine (Hwang et al. 2018) known to us, ill-defined borders with heterogeneous peripancreatic fluid collections, which were confirmed in other NPs, were identified. Moreover, the identification of necrotic debris using CT was not described in the previously reported case. In the present case, the necrotic debris with well-defined walls was identified using the CT and the findings were similar to those from previous reports in humans.

In human medicine, the 2012 revision of the Atlanta classification of acute pancreatitis outlined improvements to the clinical assessment and management of acute pancreatitis and the terminology used for peripancreatic fluid collections, and pancreatic and/or peripancreatic necrosis (Thoeni 2012). Terms such as acute peripancreatic fluid collections, a pancreatic pseudocyst, acute necrotic collections, and WOPN were revised based on the classification of the peripancreatic fluid collections. The revision of the Atlanta classification focuses on the morphologic criteria obtained using an imaging-based assessment, especially CT. However, there is no classification system based on the clinical and radiological characteristics in veterinary medicine. Therefore, WOPN is still being reported as a pancreatic abscess in veterinary medicine, as formerly defined in human medicine. NP requires close monitoring because the necessity and timing of the surgery differ depending on the NP classification. Moreover, the prognosis is poor in NP cases; therefore, an accurate diagnosis according to the classification is necessary. Furthermore, reporting on WOPN might have been underestimated because an abdominal CT is not routinely performed in cases of acute pancreatitis in veterinary medicine. General anaesthesia must be used to conduct the CT examinations, and the use of anaesthesia can lead to hypoperfusion, exacerbating the pancreatic inflammatory response. Additionally, a CT examination is not routinely performed because the imaging criteria for WOPN have not been well-established in veterinary medicine. Finally, the owner's inevitable medical expense and the smaller number of hospitals with the ability to perform CT examinations may also be additional reasons that WOPN is underestimated in veterinary medicine. More cases might have been reported if CT was routinely used in the diagnosis of WOPN in veterinary medicine. Therefore, the present case report suggests the possibility of using the same WOPN classification in veterinary medicine as that used in human medicine. This recommendation can be considered in the future, and lessons learnt from this case could assist in driving new research initiatives.

Differentiating WOPN from pancreatic pseudocysts is clinically important since pseudocysts are long term sequelae of interstitial oedematous pancreatitis; thus, their treatment and prognosis differ from those of WOPN. In humans, the use of CT is relatively accurate in differentiating between WOPN and a pseudocyst. On the CT, the WOPN characteristics differ from those of pseudocysts and include a larger size, extension into the paracolic space, an irregular wall definition, the presence of fat attenuation debris in the pancreatic fluid collections, a pancreatic parenchymal deformity or discontinuity, and the absence of dilation of the main pancreatic duct (Takahashi et al. 2008). Differentiating WOPN from pseudocysts is also important in veterinary medicine because

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pseudocysts are frequently reported (Jerram et al. 2004; Park et al. 2018), and WOPN misdiagnosed as a pseudocyst can lead to an inaccurate treatment and a poor prognosis. In the present case, the CT characteristics described above, with the exception of the pancreatic parenchymal deformity or discontinuity, were identified and used to differentiate the WOPN from a pseudocyst. Further studies are needed to determine if the CT diagnostic criteria in veterinary medicine differ significantly from those applied in human medicine.

WOPN can often be difficult to distinguish from an intra-abdominal neoplasia, especially a pancreatic neoplasia, as the presenting clinical and radiographic features are often similar. In particular, in veterinary medicine, there have been few reports regarding WOPN; therefore, residual fluid collections with necrotic debris can be misdiagnosed as an intra-abdominal neoplasia. Residual fluid collections can also appear as cystic pancreatic neoplasms; this is more common if the masses are multifocal or extensive. Likewise, there have been cases in which NP, which is thought to be WOPN, mimicked pancreatic cancer in humans (Thurnher et al. 2001). Since NP is characterised by a high incidence of local complications and a high mortality rate (Munsell and Buscaglia 2010; Cunha et al. 2014), the accurate diagnosis and proper and timely treatment are very important. In the present case, the radiographs and ultrasonographic images showed radiologically necrotic masses in the left mid-abdomen. These necrotic masses were considered as an intra-abdominal neoplasia based on the initial imaging examinations. However, following the CT examinations, the masses were diagnosed as WOPN, thus ruling out the initial diagnosis of an intra-abdominal neoplasia. Therefore, WOPN should be considered as a differential diagnosis when multifocal, round, poorly vascularised cystic masses are identified on the radiography and ultrasonography. Additionally, a CT examination is recommended for the accurate diagnosis.

A contrast-enhanced CT is considered to be the gold standard imaging modality for diagnosing acute pancreatitis in human medicine (Trout et al. 2010; Bharwani et al. 2011). It plays a critical role in not only diagnosing the morphological complications and monitoring treatment (Baudin et al. 2012), but also in excluding the possibility of neoplasms. Moreover, CT has a clinical value as a prognostic tool for NP in human medicine (Mortele et al. 2004). The CT severity index and the modified CT severity index, which evaluate the degree of necrosis of the pancreatic parenchyma, are used for the early detection of the disease severity. In previous reports, the morbidity and mortality rates were higher when the extent of the pancreatic necrosis identified based on the modified CT severity index was greater than 30% (Balthazar 2002). Applying this criterion to the present case suggests a good prognosis because the necrosis in the pancreatic parenchyma was not severe; additionally, the patient showed good recovery. Therefore, the CT imaging characteristics and the prognostic criteria for WOPN did not significantly differ from those of humans in the present case. More research is needed to confirm the criteria for the prognostic evaluation based on CT in veterinary medicine.

In conclusion, WOPN should be considered as a differential diagnosis when multifocal, round, and poorly vascularised cystic masses are identified on the radiography and ultrasonography, especially in dogs with clinically suspected acute pancreatitis. WOPN can be misdiagnosed as an intra-abdominal neoplasia if the clinical and radiographic features are similar; therefore, an additional CT examination is recommended for an accurate diagnosis. A contrast-enhanced CT examination is a useful tool for the diagnosis, prognostic evaluation, and treatment planning in dogs with WOPN.

## Conflict of interest

The authors declare no conflict of interest.

## REFERENCES

Balthazar EJ. Acute pancreatitis: Assessment of severity with clinical and CT evaluation. Radiology. 2002 Jun;223(3): 603-13.

Baudin G, Chassang M, Gelsi E, Novellas S, Bernardin G, Hebuterne X, Chevallier P. CT-guided percutaneous catheter drainage of acute infectious necrotizing pancreatitis: Assessment of effectiveness and safety. AJR Am J Roentgenol. 2012 Jul;199(1):192-9.

Bharwani N, Patel S, Prabhudesai S, Fotheringham T, Power N. Acute pancreatitis: The role of imaging in diagnosis and management. Clin Radiol. 2011 Feb;66(2):164-75.

Cunha EF, Rocha Mde S, Pereira FP, Blasbalg R, Baroni RH. Walled-off pancreatic necrosis and other current con-

https://doi.org/10.17221/123/2020-VETMED

cepts in the radiological assessment of acute pancreatitis. Radiol Bras. 2014 May-Jun;47(3):165-75.

French JM, Twedt DC, Rao S, Marolf AJ. Computed tomographic angiography and ultrasonography in the diagnosis and evaluation of acute pancreatitis in dogs. J Vet Intern Med. 2019 Jan;33(1):79-88.

Hughey M, Taffel M, Zeman RK, Patel S, Hill MC. The diagnostic challenge of the sequelae of acute pancreatitis on CT imaging: A pictorial essay. Abdom Radiol. 2017 Apr; 42(4):1199-209.

Hwang TS, Park SJ, Lee JH, Jung DI, Lee HC. Walled-off pancreatic necrosis in a dog. J Vet Clin. 2018 Aug;35(4): 146-9.

Jerram RM, Warman CG, Davies ES, Robson MC, Walker AM. Successful treatment of a pancreatic pseudocyst by omentalisation in a dog. N Z Vet J. 2004 Aug;52(4): 197-201.

Mansfield C. Acute pancreatitis in dogs: Advances in understanding, diagnostics, and treatment. Top Companion Anim Med. 2012 Aug;27(3):123-32.

Mier J, Leon EL, Castillo A, Robledo F, Blanco R. Early versus late necrosectomy in severe necrotizing pancreatitis. Am J Surg. 1997 Feb;173(2):71-5.

Morgan DE, Baron TH, Smith JK, Robbin ML, Kenney PJ. Pancreatic fluid collections prior to intervention: Evaluation with MR imaging compared with CT and US. Radiology. 1997 Jun;203(3):773-8.

Mortele KJ, Wiesner W, Intriere L, Shankar S, Zou KH, Kalantari BN, Perez A, vanSonnenberg E, Ros PR, Banks PA, Silverman SG. A modified CT severity index for evaluating acute pancreatitis: Improved correlation with patient outcome. AJR Am J Roentgenol. 2004 Nov;183(5): 1261-5.

Munsell MA, Buscaglia JM. Acute pancreatitis. J Hosp Med. 2010 Apr;5(4):241-50.

Park J, Lee M, Lee H, Jeong SM. Treatment of pancreatic pseudocyst with omentalization in a dog. Korean J Vet Res. 2018;58(3):163-5.

Stamatakos M, Stefanaki C, Kontzoglou K, Stergiopoulos S, Giannopoulos G, Safioleas M. Walled-off pancreatic necrosis. World J Gastroenterol. 2010 Apr 14;16(14):1707-12.

Takahashi N, Papachristou GI, Schmit GD, Chahal P, LeRoy AJ, Sarr MG, Vege SS, Mandrekar JN, Baron TH. CT findings of walled-off pancreatic necrosis (WOPN): Differentiation from pseudocyst and prediction of outcome after endoscopic therapy. Eur Radiol. 2008 Nov;18(11): 2522-9.

Thoeni RF. The revised atlanta classification of acute pancreatitis: Its importance for the radiologist and its effect on treatment. Radiology. 2012 Mar;262(3):715-64.

Thurnher MM, Schima W, Turetschek K, Thurnher SA, Fugger R, Oberhuber G. Peripancreatic fat necrosis mimicking, pancreatic cancer. Eur Radiol. 2001 May;11(6):922-5.

Trout AT, Elsayes KM, Ellis JH, Francis IR. Imaging of acute pancreatitis: Prognostic value of computed tomographic findings. J Comput Assist Tomogr. 2010 Jul;34(4):485-95.

Zaheer A, Singh VK, Qureshi RO, Fishman EK. The revised Atlanta classification for acute pancreatitis: Updates in imaging terminology and guidelines. Abdom Imaging. 2013 Feb;38(1):125-36.

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